National Aeronautics and
Space Administration

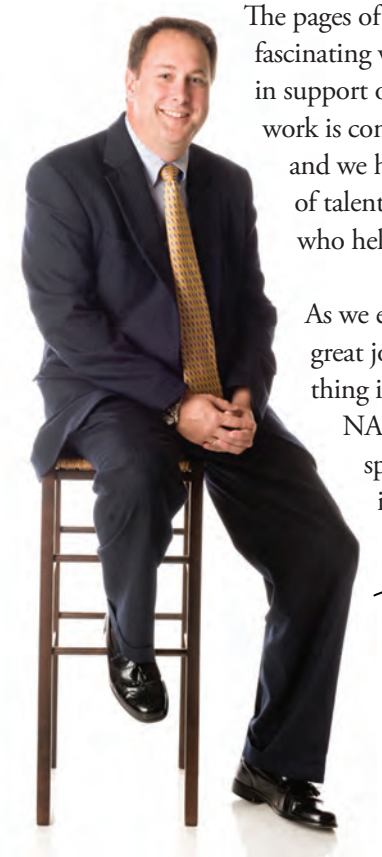
marshall

Launching the Future of Science and Exploration

Launching the Future of Science and Exploration

On July 1, 2010, Marshall Space Flight Center celebrates its 50th anniversary—50 years of innovation, inspiration, and discovery! Since the beginning, Marshall has played a vital role in our Nation's space program.

The Center's expertise in science and engineering provides America with unique and critical capabilities to take the next giant leap in space exploration. As a natural extension of our historical involvement in the Apollo and Shuttle programs, we are developing space exploration vehicles and hardware for the future. We also develop and manage scientific spacecraft and instruments, conduct cutting-edge research, and manage systems that enable living and working in space.



The pages of this booklet reveal the fascinating work Marshall is doing in support of NASA's goals. Our work is complex and challenging, and we have an incredible team of talented and dedicated people who help drive our success.

As we embark on the next great journey of discovery, one thing is certain—for Marshall, NASA, and our Nation's space program—the best is yet to come!

Robert Lightfoot
Director

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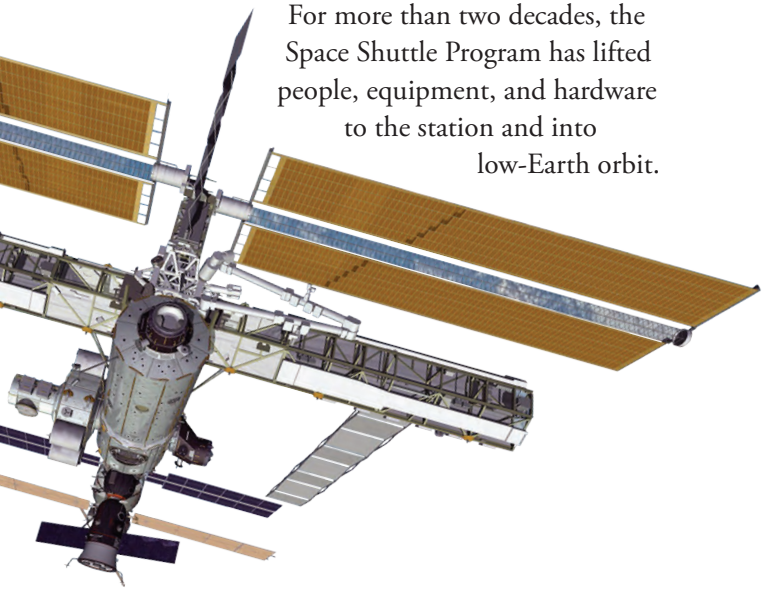
Exploration Plans

NASA is moving forward with a new focus — to go beyond Earth orbit for purposes of human exploration and scientific discovery. NASA will use the space shuttle to complete the International Space Station, before retiring the shuttle and delivering a new generation of spacecraft to venture out into the solar system.

The space station, which is scheduled to be completed by 2010, is a laboratory where we are learning how to live and work in space. Building hardware that can survive and function in a harsh environment is a crucial step in preparation for long-duration support of life beyond the Earth's protective atmosphere.



For more than two decades, the Space Shuttle Program has lifted people, equipment, and hardware to the station and into low-Earth orbit.

NASA is now developing an exploration vehicle system, called Constellation, to expand our capabilities. This new system, powered by the Ares I crew launch vehicle and Ares V heavy cargo launch vehicle, will increase the number of crew members and the amount of cargo that can be transported into space. NASA's plans include using the new system to service the space station by 2015.

As humans go beyond Earth and learn how to live on other planets, we must develop methods for using the resources found there. The moon is a crucial stepping stone along that path — a harsh and distant world, yet one that is only a three-day journey from Earth. NASA is already preparing robotic missions to go to the moon. The Ares rockets will take humans there by 2020 to begin construction of a permanent lunar outpost.

Completing the space station and constructing a lunar outpost as preparation for further exploration are critical milestones in America's quest to become a truly spacefaring nation. And Marshall Space Flight Center has a vital role in that future.

ABOUT MARSHALL

From the development of mighty rocket engines to extraordinary scientific discoveries about our universe, Marshall Space Flight Center in Huntsville, Alabama, is launching the future of science and exploration.

While Huntsville has become known as the "Rocket City," propulsion is only one of Marshall's many cutting-edge exploration and research projects. The center uses its talented team, extensive experience, and state-of-the-art facilities to support NASA's human and robotic exploration initiatives as well as missions of scientific discovery in our solar system and beyond.

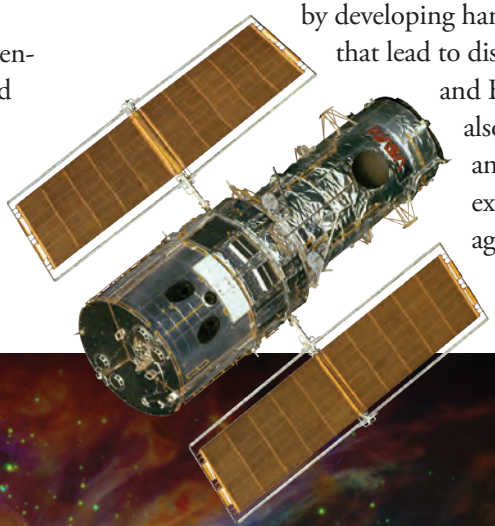
The results? In addition to the most powerful rockets ever designed, our nation benefits from enhanced understanding of our universe, groundbreaking scientific discoveries, improvements to life on Earth, and an increased ability to live and work in space.

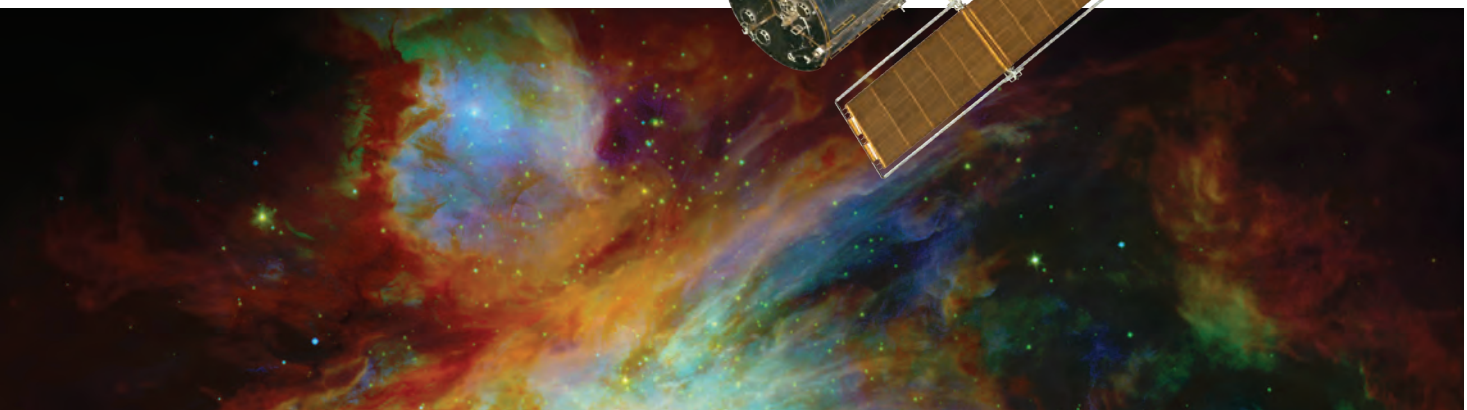
Marshall is one of NASA's ten field centers working under the direction and guidance of NASA Headquarters in Washington. Marshall supports the agency through its expertise in propulsion, engineering, science, space operations, and project and program management.

The center provides the engineering expertise behind propulsion and transportation systems such as the space shuttle and the new Ares rockets.

Supporting around-the-clock operations on the International Space Station through the Payload Operations Center, Marshall develops, integrates, and operates major logistics, life support, and scientific experiment components and systems.

The center conducts fundamental and applied scientific research and enables scientific discovery by developing hardware and instruments that lead to discoveries in space science and Earth science. Marshall also provides technical and project management expertise in support of the agency's science and mission systems programs.





From Exploration to Opportunity

Marshall is an engine of opportunity for its community and the nation. The center draws numerous private-sector high-tech companies to the area, creating thousands of high-paying jobs and attracting the talented people needed to fill them. Marshall's economic impact reaches across North Alabama and the nation.

Fiscal Year 2008:

- **$2.6 billion** actual budget
- **More than 7,000** employees (2,634 civil service)
- **$1 billion** impact to Alabama economy
- **6th largest employer** in the Huntsville/Madison County area
- **4.5 million** square feet of space occupied in Huntsville
- **2.2 million** square feet of manufacturing space at the Marshall-managed Michoud Assembly Facility in New Orleans

Educational Outreach

- Provides more than $20 million in procurements and grants to Alabama educational and nonprofit organizations and more than $113 million across the United States
- Coordinates the Annual Great Moonbuggy Race engaging high school students in engineering competition
- Hosts the NASA Student Launch Initiative, involving middle school, high school, and university students in designing, building, and testing reusable rockets

Location

Marshall is adjacent to Cummings Research Park, the nation's second-largest research park with more than 285 high-tech enterprises, U.S. space and defense agencies, and the University of Alabama in Huntsville.

Doing Business With Marshall

Engineering businesses and professionals have several options for working with Marshall Space Flight Center:

- **Provide goods and services to Marshall** (procurement and acquisition)
- **Use Marshall resources in support of your objectives** (Space Act Agreements)
- **Use NASA technologies to improve quality of life on Earth** (Technology Transfer)

Visiting Marshall

Marshall is located on the U.S. Army's Redstone Arsenal with restricted access. Decals and badges can be obtained for visitors with prior approval at the Redstone Arsenal Visitor's Center at Gate 9 on Research Park Boulevard/Rideout Road South.

The Visitor Information Center for Marshall is located at the U.S. Space & Rocket Center. Interactive exhibits and unique historic artifacts demonstrate Marshall's critical role in supporting NASA's missions.

Learn More

About Marshall
www.nasa.gov/centers/marshall/about

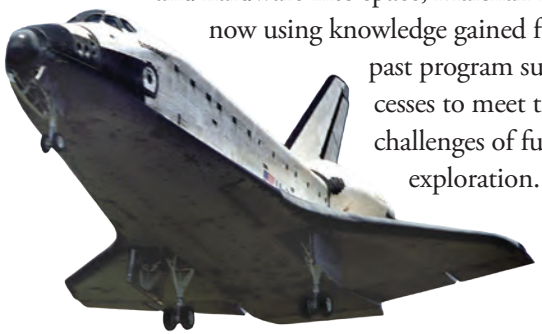
Aerial view of Marshall Space Flight Center

LAUNCHING THE FUTURE

Putting People and Payloads Into Space

Marshall Space Flight Center is the leader in meeting America's space transportation challenges and putting new rockets and explorers into space.

From Mercury to Gemini, from Apollo to the space shuttle, Marshall has been at the forefront of America's space propulsion and transportation accomplishments. Leading the way in moving people, supplies, and hardware into space, Marshall is now using knowledge gained from past program successes to meet the challenges of future exploration.



The new Constellation fleet — now more than four years into development — includes the Ares I crew launch vehicle, the Ares V cargo launch vehicle, the Orion crew exploration vehicle, and the Altair lunar lander.

The design of the powerful Ares rockets includes elements from the Marshall-developed Saturn rockets and space shuttle propulsion systems. However, increased capacity and power will enable NASA to transport more crew members into space and to lift larger and heavier spacecraft and equipment than the space shuttle allowed. The shuttle is limited to low-Earth orbit, but the Ares launch vehicles will reach far beyond to accommodate further exploration.

Progress on the rockets will move into a new phase in 2009 with Ares I-X, the first Ares I test flight. The first crewed launch of the Ares I rocket to the space station is planned for 2015.

Why explore?

To uphold America's leadership through:

- Technological advancement
- Economic opportunity
- Scientific discovery
- National security

The things we will learn from establishing a lunar outpost will benefit all of mankind.

Why the moon?

It's close

The moon is just a three-day journey.

It's informative

The moon reveals a planetary history unavailable anywhere else.

It's necessary

The moon is a stepping stone for future missions to other destinations.

Space Shuttle

During nearly three decades of flight, the space shuttle has supported the Mir space station and the International Space Station; made maintenance flights to the Hubble Space Telescope; launched planetary missions to study Jupiter, Venus, and the sun; and enabled hundreds of scientific studies in onboard laboratories supported by Marshall.

Engineers at Marshall designed, developed, and continue to maintain the space shuttle main engines, the external fuel tank, and the solid rocket boosters.

Upon completion of the Space Shuttle Program, NASA will have used the shuttle to fly more than 130 missions into low-Earth orbit transporting people, supplies, and equipment to the International Space Station and to launch numerous missions of exploration into our solar system and beyond.

Main Engines

The space shuttle main engines are the most advanced liquid-fueled rocket engines ever built. Three main engines are mounted in the back of the vehicle and are ignited just before liftoff. Along with the solid rocket boosters, the engines provide the thrust to lift the shuttle off the ground for the initial ascent. They operate for 8.5 minutes during liftoff and ascent, burning the half-million gallons of propellants stored in the external tank. The main engines create a combined maximum thrust of more than 1.2 million pounds.

After the solid rocket boosters separate, the main engines provide thrust that accelerates the shuttle from 3,000 mph to more than 17,000 mph in just six minutes. The engines shut down just before the shuttle reaches orbit. After the shuttle lands, the engines are removed, rechecked, and refurbished for their next flight.

Installation of space shuttle main engines on Space Shuttle Discovery

External Tank

The 153.8-foot-long external tank holds more than 530,000 gallons of liquid hydrogen (fuel) and liquid oxygen (oxidizer), which are used as propellants for the shuttle's three main engines. The external tank is the "backbone" of the shuttle during launch, providing structural support for attachment with the solid rocket boosters and shuttle vehicle, and absorbing the 7.3 million pounds of thrust generated during launch. After the fuel is consumed at approximately 8.5 minutes into the shuttle flight, the external tank separates and falls in a preplanned trajectory. Most of the tank disintegrates in the atmosphere, and the remainder falls into the ocean. The external tank is the only element of the space shuttle that is not reused.

Reusable Solid Rocket Boosters

The twin solid rocket boosters operate in parallel with the main engines during the first two minutes of powered flight to provide the thrust needed for the shuttle to escape the pull of Earth's gravity. The solid rocket boosters have a combined thrust of about 6.6 million pounds at launch to help propel the space shuttle off the launch pad and up to an altitude of about 24 nautical miles.

After their two minutes of flight, the boosters separate, descend under parachutes, and land in the Atlantic Ocean. The used solid rocket boosters are recovered, refurbished, refueled, and reused for future missions.

External tank departing Michoud Assembly Facility

America's New Rockets: Ares I and Ares V

The Ares I and Ares V rockets are key components of the Constellation Program. The Ares Projects are managed at Marshall, but building the Ares I is a national effort supported by more than 200 companies located across the nation from Connecticut to California.

These safe, reliable, and cost-effective space launch vehicles will replace the space shuttle fleet and carry a new generation of explorers to the moon and to other destinations in our solar system. By extending human presence to the moon and beyond, these explorers will enable us to seek answers to fundamental questions about the universe and our place in it, create new economic opportunities to improve life on Earth, and develop global partnerships that will promote cooperation.

Both the Ares I and Ares V rockets use solid rocket boosters that are derived from the space shuttle solid rocket boosters.

This hardware commonality makes operations more cost effective by minimizing design and manufacturing costs.


Friction stir welder

Marshall is the home of the Ares Projects, which are responsible for designing and developing Ares vehicle hardware, evolving proven technologies, and testing components, software, and systems.

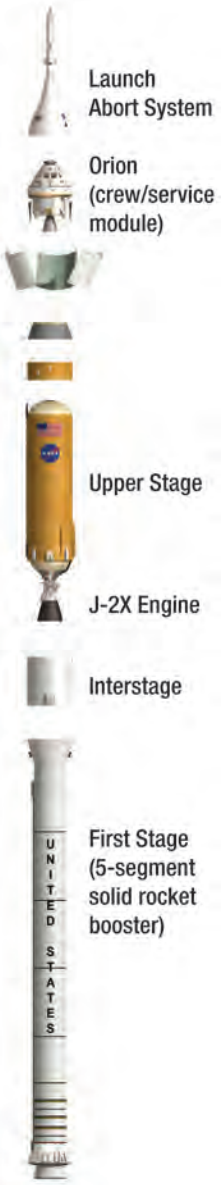
Ares I
Crew Launch Vehicle

The Ares I crew launch vehicle will deliver the Orion crew exploration vehicle and cargo payloads to Earth orbit. The first task for Ares I will be to use its 25-ton payload capacity to replace the space shuttle in delivering resources, supplies, and scientific instruments to the space station.

Design of the Ares I rocket is well underway, and actual hardware components have been built and delivered to Kennedy Space Center in preparation for the first test flight.

The Ares I is a two-stage rocket topped by the Orion spacecraft, which can be used to transport astronauts or supplies to the station or to rendezvous with the Ares V Earth departure stage for travel to the moon. Orion's launch abort system can move the crew quickly away in case of launch emergency.

The diagram to the right shows the segments of the Ares I rocket for crewed exploration.



Ares V
Cargo Launch Vehicle

Planning and design are underway at Marshall for the hardware, propulsion systems, and associated technologies needed for NASA's Ares V cargo launch vehicle, the heavy lifter of America's next-generation space fleet. Its mission will be to launch Altair—the lunar craft for transporting astronauts and supplies to and from the moon—and the materials required for establishing a lunar outpost.

As illustrated in the diagram to the left, the versatile Ares V is a vertically stacked, two-stage rocket with two reusable solid rocket boosters.

The heavy lift capability of Ares V will enable other exploration, scientific, and commercial payloads, such as lunar experiments, rovers, habitats, and large telescopes. This lift capability will allow NASA to undertake crewed missions to destinations beyond the moon in the future.

The Lunar Exploration Vehicle Architecture diagram below describes how the Constellation vehicles work together to deliver the crew to the lunar surface and back to Earth.

When the Ares V launches, it will be powered by six liquid-fueled RS-68B engines in its core stage and two 5.5-segment solid rocket boosters. The boosters and core stage will separate from the launch vehicle when they have expended their fuel. Then the Earth Departure Stage (EDS), powered by a J-2X engine, will carry the Altair into low-Earth orbit. During this phase of flight, the loiter skirt attached to the bottom of the EDS, will provide electrical power and space debris protection.

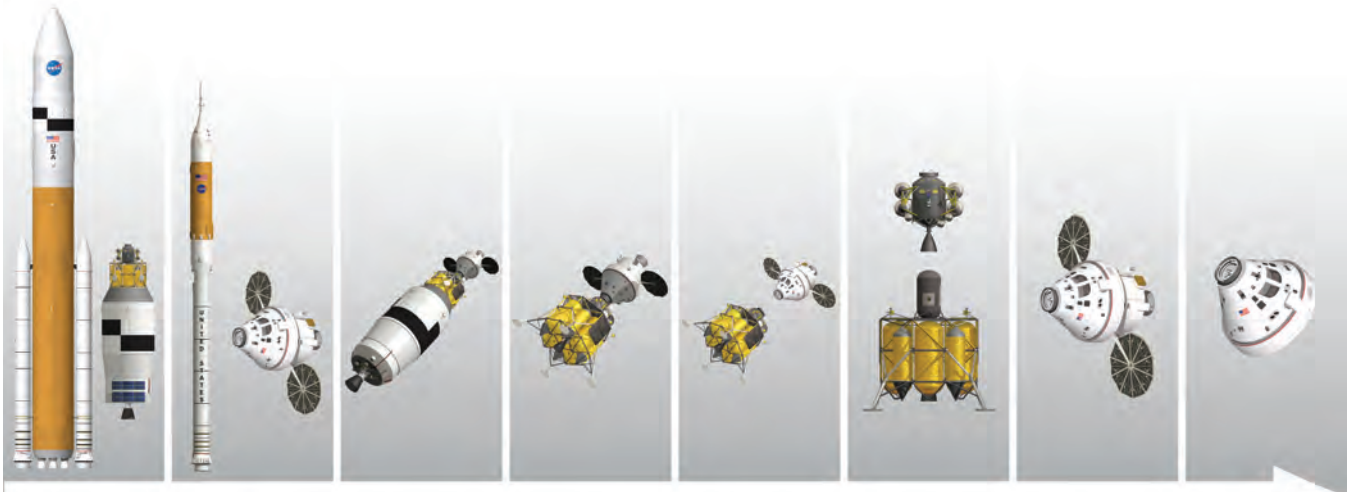
After launch, the Ares I first stage reusable solid rocket booster will separate, and the Orion crew exploration vehicle will be propelled into low-Earth orbit by the upper stage J-2X main engine and the service module's propulsion system.

While in low-Earth orbit, Orion will rendezvous and dock with Altair. Once the two craft join, the EDS will discard the loiter skirt and fire its J-2X engine again to propel the Altair and Orion on their way to the moon.

In lunar orbit, the crew will transfer into Altair and descend to the moon's surface. The ascent stage of Altair will return the crew from the lunar surface to the orbiting Orion vehicle, which will return the crew to Earth.

The first crewed lunar excursion is scheduled to launch in the 2020 timeframe.

Lunar Exploration Vehicle Architecture



Ares V will launch the EDS and the Altair lunar lander into Earth orbit.	Ares I will launch the Orion crew exploration vehicle into Earth orbit.	Orion will dock with Altair, and the EDS will propel them on their way.	The EDS will fall away, and Orion/Altair will continue to the moon.	Orion will orbit the moon while Altair's descent stage takes the crew to the lunar surface.	Once their mission is complete, the crew will board Altair's ascent stage and return to Orion.	Powered by its solar arrays, Orion will propel the crew back to Earth orbit.	After separation from the solar arrays, the Orion capsule will return the crew to Earth.

Ares I-X Test Flight

The first test flight for Ares I is scheduled to occur in 2009. That flight, Ares I-X, will be a suborbital development test, providing NASA its first opportunity to demonstrate and collect key data to inform the Ares I design. Engineers will observe the vehicle's performance in roll and overall vehicle control; staging and separation; aerodynamics and vehicle loads; first stage entry dynamics for recovery; and vehicle integration, assembly, and launch operations.

Ares I-X hardware is being built at several NASA centers and industry partner locations. Marshall is managing the first stage, roll control system, and avionics systems. The launch will take place at Kennedy Space Center.

Learn more

Marshall — Space Shuttle Technology Spinoffs
www.nasa.gov/centers/marshall/news/background/facts/SpinoffsFromTheShuttleFS.html

Human Exploration
www.nasa.gov/centers/marshall/moonmars/explore.html

Constellation — NASA's New Spacecraft: Ares and Orion
www.nasa.gov/ares

Benefiting Life on Earth

Space transportation systems stimulate development of technologies in many areas. The Space Shuttle Program alone has generated more than 100 technologies that have benefited U.S. industry, improved our quality of life, and created jobs for Americans.

A sampling of technologies originating from space shuttle work done at Marshall includes:

Prosthesis material — A commercial derivative of the foam insulation used to protect the shuttle's external tank replaced the heavy, fragile plaster once used to produce master molds for prosthetics.
Automotive insulation — Materials from the space shuttle thermal protection system are being used on NASCAR racing cars to protect drivers from the extreme heat generated by the engines.
Insulating paint powder — A powder created to help insulate the space shuttle is being used in exterior house paint to insulate residential homes as well — making it a "green" paint solution.

LIVING AND WORKING IN SPACE

Supporting Life in Space

Marshall Space Flight Center develops and tests life support systems and manages communications and operations for scientific experiments in the near weightless environment of space.

As NASA prepares for extended travel to the moon and beyond, scientists, engineers, and technicians at Marshall are developing and testing life support systems that will make it possible for astronauts to survive long-duration visits in space environments.

Current efforts at Marshall that will positively impact our future presence in space include designing and building hardware and systems for the International Space Station. The center is home to the Payload Operations Center (POC), the command post that manages science for the station.

Marshall is also developing systems for future life support and living environments on the moon and beyond so we can establish outposts from which to conduct science and further explore the universe.

Astronauts working onboard the International Space Station

International Space Station

Marshall develops, tests, and provides engineering expertise for hardware and systems that enable astronauts to live and work in space onboard the station, the largest orbital facility ever built.

Marshall led the design, development, and testing of the **Regenerative Environmental Control and Life Support System (ECLSS)** for the space station. This system provides water and oxygen for the crew, recycling waste water into usable water and reducing resupply costs.

Marshall also developed the **Materials Science Research Rack**, which is used for basic materials research, leading to the discovery of new or improved materials and new applications for existing materials.


Microgravity Science Glovebox

Marshall manages other space station work that includes:

EXPRESS Racks house a variety of payloads in a drawer or locker-type interface, versatility that will enable long-term use of the space station.

The **Harmony Module** connects three station science experiment facilities, growing the space station from the size of a three-bedroom house to the size of a typical five-bedroom house.

Multi-purpose Logistics Modules, onboard the space shuttle, carry supplies such as food, clothing, spare parts, and research equipment to the station and are returned to Earth with cargo no longer needed on the station.

The **Microgravity Science Glovebox** enables scientists to participate in the assembly and operation of experiments in space by providing a sealed, negative pressure (vacuum) workspace for manipulation of hardware and samples.

The **Window Observational Research Facility** will enable viewing and Earth imaging using cameras, multispectral scanners, and other specialized equipment attached to the U.S. Destiny lab's optical quality window.

Node 3, a pressurized module headed for the station in late 2009, will house the ECLSS racks and the crew's waste and hygiene compartment, and will enable the addition of future modules.

Payload Operations Center

Located at Marshall, the Payload Operations Center (POC) is the science command post for the space station. The POC manages all U.S. science and research experiments onboard the station, and coordinates all payload-related mission-planning work; hardware deliveries; and retrieval, training, and safety programs for station crew and flight controllers. The POC is also certified as a backup control center for space station flight operations in support of Johnson Space Center in Houston during hurricanes or other emergencies.

Unique capabilities in the POC at Marshall allow researchers around the world to perform cutting-edge science in the near weightless environment of space. Communication lines and computers connect the POC with the Mission Control Center at Johnson Space Center—the direct link to the space station.

The operations center also can command science operations remotely, receive vital information from the station through telemetry signals, and monitor research operations using downlinked television. This experience will be important for future lunar science missions.

Learn More

Payload Operations Center tour video
www.nasa.gov/centers/marshall/shuttle_station/ops.html

Mission Operations Laboratory
http://ed.msfc.nasa.gov/eo/

International Space Station (ISS) Mission page
www.nasa.gov/mission_pages/station

Future Systems

Numerous systems will be required for humans to live and work in the harsh environment of space. Systems being researched and developed at Marshall include:

Exploration Life Support Systems
Life support hardware that can generate and recycle life-sustaining resources is essential for long-duration trips into space. The Marshall team's experience in creating space station systems will contribute to the next generation of life support systems.

The Exploration Life Support Project is developing technologies for use on the moon and beyond.

Radiation Hardened Electronics for Space Environments (RHESE) Project
Managed by Marshall, the RHESE project is expanding the current state of the art in radiation hardened electronics to develop high-performance devices that can withstand the extreme radiation and temperatures of space.

In-Situ Resource Utilization (ISRU)
ISRU means "living off the land." Human habitation on the moon will require the use of existing resources, so that at least some of the necessary materials will not have to be transported from Earth. ISRU includes mining for resources and determining how to use them to create necessities. For example, oxygen might be extracted from lunar regolith (moon soil) to produce water or fuel.

Benefiting Life on Earth

From microcomputers to magnetic resonance imaging (MRI), technology developed for use on the International Space Station has found many uses to benefit life on Earth.

Airplane Safety — The Personal Cabin Pressure Altitude Monitor and Warning System is a hand-held personal safety device that warns airplane pilots of potentially dangerous cabin pressure conditions before lack of oxygen becomes a threat.

Medical Robotics — Autonomous robotic arms developed to recover crew or tools outside the space station are being used in human-collaborative medical surgery and for emergency response to chemical, biological, and nuclear materials.

Pure Water — A water purification system using technology from the station's Environmental Control and Life Support System is improving the quality of life for Iraqis struggling to rebuild the village of Kendala.

Fresh water in Kendala, Iraq, from filtration systems based on ECLSS technologies

Photo courtesy of Water Security Corporation.

UNDERSTANDING OUR WORLD AND BEYOND

Exploring for Answers

Marshall is involved in some of the most exciting and innovative scientific discoveries of the decade, revealing awe-inspiring new worlds and turning theoretical research into tangible technologies and improvements to life on Earth.

Whether studying Earth, the solar system, or the universe beyond, Marshall experts foster a unique relationship between science and exploration, with positive outcomes resulting from interdependence of these two disciplines. Neither discipline can thrive without the other.

The center pursues new scientific knowledge with goals of increasing understanding and benefiting humankind. Marshall accomplishes this through the use of specialized scientific spacecraft for exploration, complex instruments for seeing the universe, and innovative research and monitoring techniques.

Dr. Wernher von Braun led the development of our nation's first rockets and was the first director of Marshall when it was established in 1960. Dr. Ernst Stuhlinger served as his chief scientist.

Together these early space pioneers—one a brilliant rocket designer and the other an eminent scientist—understood the critical importance of integrating science and exploration.

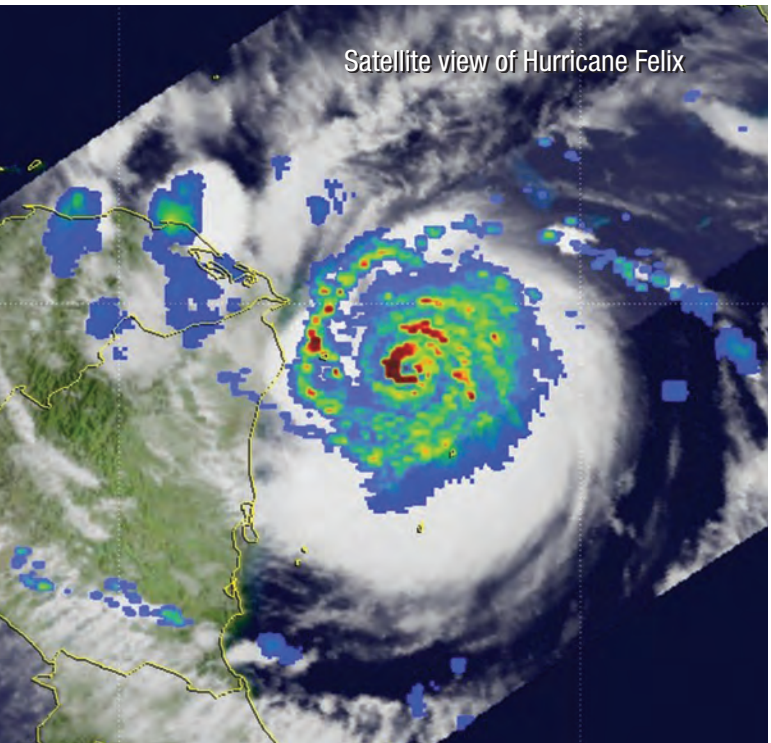
They recognized the importance of the question, "What do we plan to use this rocket for?"

Earth Science

Earth scientists at Marshall use space satellites and other tools to gather data and conduct research that can help forecasters predict weather. Advanced technologies enable scientists to observe and understand many other aspects of the global climate system and use this knowledge to improve agriculture, urban planning, and water resource management.

Hurricane Research

Marshall's atmospheric scientists are examining the forces of some of the Earth's most intense hurricanes. They are developing instruments and technologies to analyze the evolution of hurricanes and to collect data and images. For example, the Hurricane RADiometer (HIRAD) enables mapping of the surface wind field near a hurricane's eye. This information helps forecasters predict the intensity and dynamics of hurricanes, helping minimize loss of life and property damage.



Satellite view of Hurricane Felix

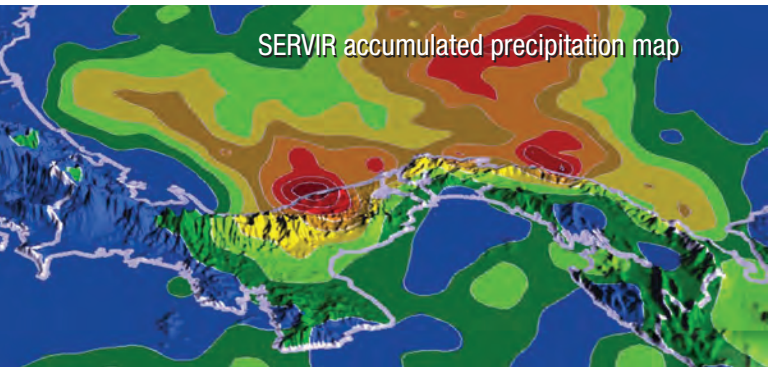
Weather Prediction

Marshall is improving our quality of life through discoveries in weather forecasting, modeling, and predicting. Marshall's Short-term Prediction Research and Transition (SPoRT) Center team works closely with National Weather Service regional forecasters, providing high-resolution NASA data and products to improve forecasts.

The Observing Microwave Emissions for Geospatial Applications (OMEGA) project uses a microwave radiometer to detect low-energy microwave radiation coming from the soil. OMEGA soil moisture data helps weather officials build better weather models, resulting in more accurate forecasts.

Environmental Monitoring

SERVIR, a Spanish acronym meaning "to serve," is a life-saving Earth science project that uses data provided by NASA satellites to improve the everyday lives of Central Americans and Eastern Africans by helping monitor and manage their environment. The SERVIR system provides critical weather and other information to rescuers during and after disasters to help them reach people quickly, significantly reducing the death toll.

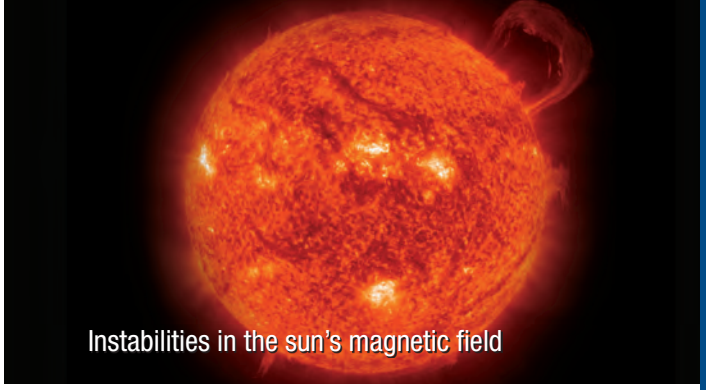

SERVIR accumulated precipitation map

Marshall's applied sciences team translates NASA remote sensing data into vital public health information. For example, linking satellite data on particulate matter with data on clinic visits for asthma patients yields information that helps public health officials predict where asthma attacks may be triggered. Through similar linking, NASA satellite data on air quality, heat indexes, temperature, humidity, and other environmental elements can help determine how the environment is influencing cardiovascular disease.

Learn More

Earth Science at Marshall
www.nasa.gov/centers/marshall/scienceandtechnology/earth.html

Science at NASA
http://science.nasa.gov


Instabilities in the sun's magnetic field

Solar Science

The sun and Earth form a tightly coupled system, with solar changes producing effects ranging from space weather to climate change. Marshall's solar physics team seeks to understand how the sun works, why it changes, and how these changes impact the Earth and the space environment.

Marshall manages the U.S. portion of the science operations for the Hinode mission, a collaborative endeavor of NASA; Japan's National Astronomical Observatory; and the space agencies of Japan, the United Kingdom, Norway, and Europe. Scientists expect to use Hinode's science results to predict solar events that affect communication systems on Earth. Hinode also helps NASA develop ways to protect crews and electronic systems on the moon from harmful solar radiation.

The Solar Ultraviolet Magnetograph Investigation (SUMI) telescope is an advanced instrument built by a team of Marshall solar physicists and engineers to measure the strength and direction of the magnetic field in the sun's transition region. Researchers hope that when this instrument is launched, it will help explain the genesis of explosive solar flares, raging sun storms, and other perilous space weather.

Learn More

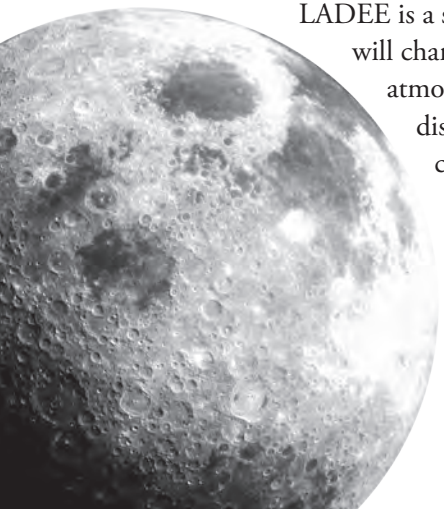
Marshall's Solar Physics Group
http://solarscience.msfc.nasa.gov/

Lunar Science

Marshall is preparing for robotic missions that will provide critical information to help engineers and scientists design and build a lunar outpost for human habitation. NASA's Lunar Precursor Robotic Program (LPRP) at Marshall manages:

- **Lunar Reconnaissance Orbiter (LRO)** providing a comprehensive Atlas of the moon to help scientists and engineers find safe landing sites, locate potential resources, understand the environment, and demonstrate new technology.
- **Lunar Crater Observation and Sensing Satellite (LCROSS)** searching for water ice in a deep crater at one of the lunar poles.
- **Lunar Mapping and Modeling Project (LMMP)** integrating data from these robotic missions with existing information to develop maps and models that enable the design of a lunar outpost.

The **Lunar Quest Program** at Marshall will manage the first two nodes in the **International Lunar Network (ILN)**, which may include monitoring stations to measure moonquakes and other geophysical phenomena. The center will also manage work done on the **Lunar Atmosphere and Dust Environment Explorer (LADEE)** project. LADEE is a small orbiter that will characterize the lunar atmosphere prior to the disruptions that will be caused by the landed missions.



Learn More

Lunar Precursor Robotic Program
http://moon.msfc.nasa.gov

Planetary Science

The Discovery and New Frontiers programs provide opportunities for missions that support focused scientific investigations complementing the agency's larger planetary exploration goals.

The programs provide:

- A range of vantage points — flybys, orbiters, landers, and sample returns — to dramatically advance our understanding of our solar system
- Fast development phases
- Considerably lower costs than larger missions
- Increased understanding about the hazards and resources in the solar system environment that will affect the extension of human presence in space

Learn More

Discovery Program
http://discovery.nasa.gov

New Frontiers Program
http://newfrontiers.msfc.nasa.gov

Exploring Our Universe

To begin to understand the wonders of the universe and observe its infinite variety, NASA created space-borne observatories that conduct astronomical studies over different electromagnetic wavelengths — visible light, gamma rays, X-rays, and infrared. Marshall scientists and the facilities available at the center are key elements in the design, development, and testing of these sophisticated techniques.

Marshall managed the design, development, and construction of the **Hubble Space Telescope**. Hubble has played a key role in revealing the age of the universe and in the discovery of dark energy — a mysterious force that accelerates the expansion of the universe.

Marshall provides scientific expertise and manages the **Chandra X-ray Observatory**, including design, development, construction, and current operation. As NASA's most sophisticated X-ray observatory, Chandra has had a profound influence on our understanding of black holes and the nature of dark matter.

The **Fermi Gamma-ray Space Telescope** is making pioneering observations of gamma-ray bursts at higher energies than ever before observed from space. Marshall developed the Gamma-ray Burst Monitor, which is now detecting and studying gamma-ray bursts with unprecedented precision.

The **James Webb Space Telescope (JWST)**, an infrared observatory, is scheduled to launch in 2013. Marshall is conducting cryogenic optical testing of the telescope's primary mirror segments in its world-class X-ray & Cryogenic Facility. Because the JWST will have a larger mirror and will go deeper into space than previous telescopes, it can peer further back in time to find the first galaxies that formed in the universe.

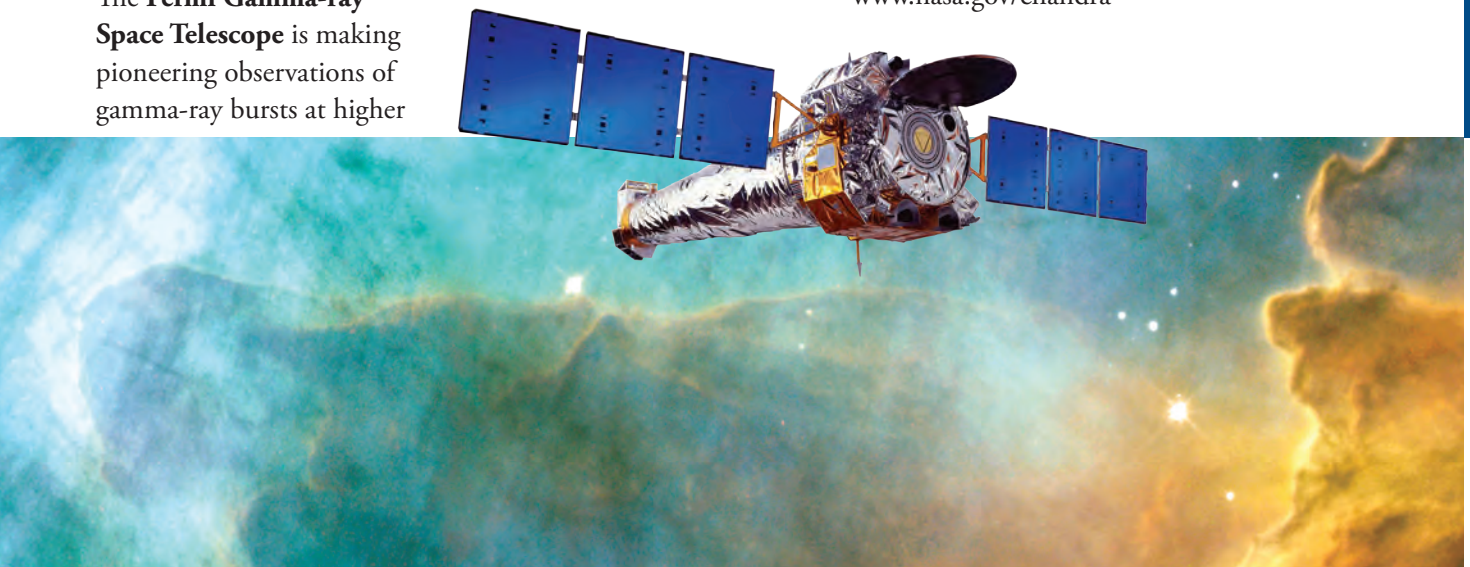
Learn More

Hubble Space Telescope
http://hubble.nasa.gov

James Webb Space Telescope
http://ngst.nasa.gov

Gamma-ray Burst Monitor
http://f64.nsstc.nasa.gov/gbm

Chandra X-ray Observatory
www.nasa.gov/chandra

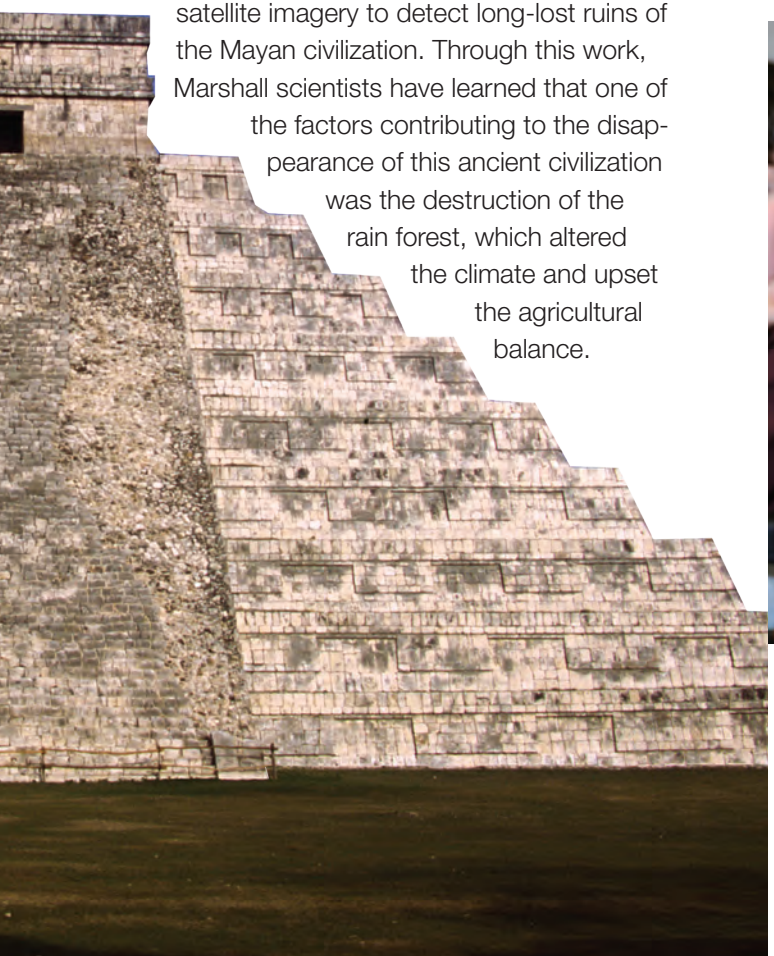


Benefiting Life on Earth

The pursuit of scientific knowledge enables us to address our fundamental questions about the history of Earth, the solar system, and the universe — and about our place in the cosmos.

Stable communications — Solar flares and other solar events can disrupt communications on Earth, disable satellites, and threaten astronauts with deadly radiation storms. Increasing our understanding of solar phenomena helps us predict solar events, allowing us to protect humans and equipment and maintain the valuable data and communications provided to Earth by satellites.

Archaeological discoveries — SERVIR uses satellite imagery to detect long-lost ruins of the Mayan civilization. Through this work, Marshall scientists have learned that one of the factors contributing to the disappearance of this ancient civilization was the destruction of the rain forest, which altered the climate and upset the agricultural balance.



Crime-solving technologies — Image-processing technology used to study meteorological images and to analyze space shuttle launch video helps law enforcement agencies improve crime-solving video. The technology removes defects caused by image jitter, image rotation, and image zoom, and was helpful in solving the pipe-bomb incident at the Atlanta Olympics.

A vibrant space exploration program will engage the public, encourage students, and help develop the high-tech workforce that will be required to address the challenges of the future.

Marshall Capabilities Power the Future

With key expertise in systems engineering and integration, Marshall Space Flight Center offers a unique blend of workforce capabilities and distinctive facilities to meet both current and future exploration goals.

Rapid prototyping of J-2X engine

Marshall team members represent a variety of engineering and scientific disciplines and have a wealth of experience, giving the center an exceptional base of knowledge. This knowledge base is enhanced by a unique combination of design and test facilities, some of which are found nowhere else in the world.

Marshall is home to highly specialized facilities:

Test facilities include historic test stands such as the Dynamic Test Stand and the Saturn V S-1C Test Stand that are being refurbished for Ares rocket testing.

State-of-the-art vacuum chambers, clean rooms, liquid oxygen and liquid hydrogen test facilities, and the Propulsion Research Development Laboratory are being used to propel America into the future.

The Michoud Assembly Facility, located in New Orleans and managed by Marshall, is one of the world's largest manufacturing plants.

The National Center for Advanced Manufacturing at Michoud is a partnership including NASA, Louisiana, and the University of New Orleans. The center provides advanced manufacturing technology.

America's largest friction stir welding tool for joining thin, high-strength metals such as aluminum-lithium will be used in manufacturing new launch vehicles and spacecraft.

Friction stir welding tool

The Payload Operations Center is the science command post for science activities onboard the International Space Station. It includes data facilities for near-real-time data, voice, video, information management, data reduction, and payload planning. Scientists around the world are provided a direct link to their experiments.

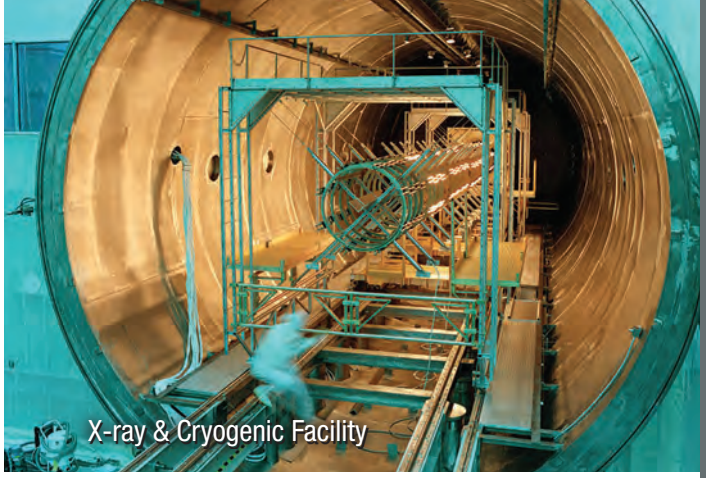
The flat floor facility, where objects can float on a thin layer of air atop the world's flattest floor, allows controllers to test techniques for spacecraft docking or remote-controlled robotics.

Marshall's Building 4600 is NASA's first certified silver-level Leadership in Environmental Engineering and Design building. LEED-certified buildings reduce environmental impact and provide energy cost savings, and healthier working and living environments.

Optics facilities include those for developing optical components such as lenses, mirrors, prisms, and gratings; for housing an extensive collection of unique advanced equipment to cut, grind, polish, and coat precision optical components; and for characterizing and calibrating optics in both Earth and space environments.

The X-ray & Cryogenic Facility and other facilities enable metrology, coating, fabrication, and more.

The first James Webb Space Telescope mirror arrives at Marshall for cryogenic testing.



X-ray & Cryogenic Facility

The National Space Science Technology Center (NSSTC) in Huntsville, Alabama, is an exceptional research facility on the campus of UAHuntsville, where many of Marshall's scientists and engineers perform cutting-edge research and development in Earth and space sciences. Work at the NSSTC is accomplished in collaboration with co-located university, private sector, and government researchers. This shared environment includes unique facilities and specialized laboratories that enable research yielding results ranging from insights on the structure and evolution of the universe to a more complete understanding of the Earth's global climate system.

Learn More

Michoud Assembly Facility
www.nasa.gov/centers/marshall/michoud

National Center for Advanced Manufacturing
www.ncamlp.org

X-ray & Cryogenic Facility
http://optics.nasa.gov/facilities/xraycal.html

NSSTC
www.nsstc.org

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History Office
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Freedom of Information Act (FOIA) Requests
256–544–1837

Speaker Requests
256–544–1715

Exhibit Requests
256–544–6541

Marshall Visitor Information Center
256–837–3400

Educator Resource Center
U.S. Space & Rocket Center Complex
256–544–5812

There can be no thought of finishing, for aiming at the stars, both literally and figuratively, is the work of generations.

But no matter how much progress one makes, there is always the thrill of just beginning.

– Dr. Wernher von Braun

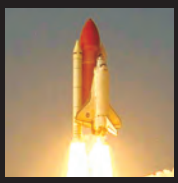
NASA's Role in America's Future

Throughout history, nations that have explored new frontiers have become the great leaders of their time. Great Britain became powerful in the 17th century through exploration and mastery of the seas. America's greatness in the 20th century was largely a result of command of the air. For future generations, the frontier will be space.

When Neil Armstrong took those first steps on the moon, the world recognized the United States for that amazing accomplishment. As we led in development of the space shuttle and of the International Space Station, the world continued to recognize America as the leader in space.

Now, we enter a new era. As other nations announce their plans for human exploration, a new challenge lies ahead. To continue our preeminence in space, we must proceed steadfastly with our nation's exploration policy and return to the moon—this time to stay.




National Aeronautics and Space Administration

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